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Practitioner's Docket No. 5871-Z-DIV

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): William W. Rowley

For (title): METHOD FOR MANUFACTURING CROSSLINKED OVERMOLDED PLUMBING  
TUBES

1. Type of Application

This transmittal is for a divisional application.

2. Benefit of Prior U.S. Application (35 U.S.C. 119(e), 120, or 121)

The new application being transmitted claims the benefit of prior U.S. application. Enclosed are  
ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S.  
APPLICATION CLAIMED.

CERTIFICATION UNDER 37 C.F.R. 1.10\*

(Express Mail label number is **mandatory**.)

(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United  
States Postal Service on this date APRIL 16, 1999, in an envelope as "Express Mail Post Office to Addressee," mailing  
Label Number EL12213819305, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Stephen L. Grant  
(type or print name of person mailing paper)

Sgt. Grant  
Signature of person mailing paper

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obtain a date of mailing or transmission for this correspondence.

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"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an  
oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will  
**not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

**3. Papers Enclosed**

A. Required for filing date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

11 Page(s) of Specification

9 Page(s) of Claims

3 Sheet(s) of Drawing(s)—Formal

B. Other Papers Enclosed

3 Page(s) of declaration and power of attorney

1 Page(s) of abstract

**4. Additional Papers Enclosed**

Amendment to claims

Cancel in this applications claims 2-62 before calculating the filing fee.

Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

Preliminary Amendment

Information Disclosure Statement (37 C.F.R. 1.98)

Form PTO-1449 (PTO/SB/08A and 08B)

Citations

**5. Declaration or Oath**

Enclosed

Executed by: William W. Rowley (copy from the parent case)

**6. Inventorship Statement**

The inventorship for all the claims in this application is the same.

7. Language

English

8. Fee Calculation (37 C.F.R. 1.16)

Regular Application

CLAIMS AS FILED					
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 CFR 1.16(a) \$760.00
Total Claims (37 CFR 1.16(c))	15	- 20 =	0 x	\$18.00	\$0.00
Independent Claims (37 CFR 1.16(b))	1	- 3 =	0 x	\$78.00	\$0.00
Multiple Dependent Claim(s), if any (37 CFR 1.16(d))			+	\$260.00	\$0.00
Amendment cancelling extra claims is enclosed. Filing Fee Calculation					\$760.00

9. Small Entity Statement(s)

Status as small entity was claimed in prior application 08/827,305, filed on March 28, 1997, from which benefit is being claimed for this application under 35 U.S.C. § 121, and which status as a small entity is still proper and desired.

A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of above) \$380.00

10. Fee Payment Being Made at This Time

Enclosed

Filing Fee	\$380.00
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<b>Total Fees Enclosed</b>	<b>\$380.00</b>
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**11. Method of Payment of Fees**

Check in the amount of \$380.00 is attached.

**12. Authorization to Charge Additional Fees**

The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 15-0450.

37 C.F.R. 1.16(a), (f) or (g) (filing fees)

37 C.F.R. 1.16(b), (c) or (d) (presentation of extra claims)

**13. Instructions as to Overpayment**

Refund.

**ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF  
PRIOR U.S. APPLICATION CLAIMED**

**14. Relate Back**

Amend the specification by inserting, before the first line, the following sentence:

This application is a divisional of co-pending application Ser. No. 08/827,305, which is scheduled to issue on 20 April 1999 as U.S. Patent 5,895,695.

**15. Maintenance of Cependency of Prior Application**

**A. Conditional Petition for Extension of Time in Prior Application**

A conditional petition for extension of time is being filed in the pending **prior** application.

**16. Further Inventorship Statement Where Benefit of Prior Application(s) Claimed**

- a. This application discloses and claims only subject matter disclosed in the prior application whose particulars are set out above and the inventor in this application is the same.
- b. The inventorship for all the claims in this application is the same.

**17. Small Entity (37 CFR § 1.28(a))**

Applicant has established small entity status by the filing of a statement in parent application 08/827,305 on March 28, 1997.

A copy of the statement previously filed is included.

**18. NOTIFICATION IN PARENT APPLICATION OF THIS FILING**

A notification of the filing of this divisional is being filed in the parent application, from which this application claims priority under 35 U.S.C. § 120.



SIGNATURE OF PRACTITIONER

Reg. No. 33390  
Tel. No.: (330) 864-5550  
Customer No.: 021324

Stephen L. Grant  
Oldham & Oldham Co., L.P.A.  
1225 W. Market St.  
Akron, OH 44313

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Rowley, William W.

Application No.: 08/827,305    Group No.: 1772  
 Filed: March 28, 1997    Examiner: Dye, Rena  
 For: CROSSLINKED OVERMOLDED PLUMBING TUBES

Assistant Commissioner for Patents  
 Washington D.C. 20231

NOTIFICATION OF FILING OF CONTINUING, DIVISIONAL  
OR CONTINUED PROSECUTION APPLICATION

Notification is hereby being made of the filing of a divisional application for this case concurrently herewith.

## CERTIFICATION UNDER 37 C.F.R. 1.8(a) and 1.10\*

(When using Express Mail, the Express Mail label number is **mandatory**;  
 Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

## MAILING

- ☐ deposited with the United States Postal Service in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

37 C.F.R. 1.8(a)

37 C.F.R. 1.10\*

- ☐ with sufficient postage as first class mail. ☒ as "Express Mail Post Office to Address"  
 Mailing Label No. ELI2213819306 (mandatory)

## TRANSMISSION

- ☐ transmitted by facsimile to the Patent and Trademark Office.

Date: April 16, 1999

Signature

Stephen L. Grant  
 (type or print name of person certifying)

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 "Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

[illegible]

**SIGNATURE OF PRACTITIONER**

(Notification of Filing of Continuing, Divisional or Continued Prosecution Application—page 2 of 2)

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR**

Docket No.  
5871-Z

Serial No.

Filing Date

Patent No.

Issue Date

Applicant/ **WILLIAM W. ROWLEY**  
Patentee:

Invention: **CROSSLINKED OVERMOLDED PLUMBING TUBES**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☒ the specification to be filed herewith.  
☐ the application identified above.  
☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern or organization exists.  
☐ Each such person, concern or organization is listed below.

\*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME  
ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME  
ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME  
ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME  
ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization



I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR WILLIAM W. ROWLEY

SIGNATURE OF INVENTOR William W Rowley

DATE: 3/20/97

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

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DATE: \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

Patent and Trademark Office-U.S. DEPARTMENT OF COMMERCE

P. 06/06

FAX NO. 3308647986

OLDHAM & OLDHAM CO LPA  
3308647986

MAR-20-97 THU 17:59

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Rowley Examiner:  
Prior Serial No: 08/827,305 Art Unit:  
Filed: 16 April 1999 Date: 16 April 1999  
For: METHOD FOR MANUFACTURING CROSSLINKED OVERMOLDED  
PLUMBING TUBES

Commissioner of Patents and Trademarks  
Washington, D.C. 20231

**PRELIMINARY AMENDMENT ACCOMPANYING APPLICATION**

This paper is filed accompanying the patent application in the present case, which is a divisional of Ser. No. 08/827,305. Applicant respectfully requests that the filing fees in this case be based upon the claims as they stand amended after entry of this Preliminary Amendment. As a result of the amendments, there are fifteen total claims, with one independent claim. This is within the limits of twenty total and three independent claims provided by the basic filing fee, so no fees for excess claims are believed to be due.

**AMENDMENTS**

**In the Specification:**

At Page 1, please amend the title by inserting before the words -- METHOD FOR MANUFACTURING -- before the word "CROSSLINKED".

At Page 1, immediately after the title, please insert the following: -- This application is a divisional of co-pending application Ser. No. 08/827,305, which is scheduled to issue as U.S. Patent No. 5,895,695 on 20 April 1999. --

**In the Abstract:**

Please delete the present abstract in its entirety and replace it with the following:

-- A process is disclosed for overmolding crosslinked tubing ends onto a crosslinkable tube. The tube, made of a first polymer, has an inner diameter. The tube is inserted at least partially into a mold and at least partially onto a cylindrical mandrel having a base and a tip. The

mandrel has an outer diameter dimensioned to allow the inner diameter of the tube to slide thereon. The mold contains a void for injection of a second polymer. The void co-acts with the mandrel and the tube to define an overmolding shape. After injection molding the second polymer over the tube and the mandrel in the void of the mold, the first and second polymers are crosslinked. Different embodiments of the overmolding shape are taught. --

### In the Claims:

Please amend Claim 1 as follows:

1. (amended) A process for overmolding tubes comprising the steps of:  
inserting a tube of a first polymer, having an inner diameter, at least partially into a mold and at least partially onto a cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said mandrel dimensioned to allow the inner diameter of the tube to slide thereon, said mold containing a void for receiving a second polymer, the void co-acting with the mandrel and the tube to define an overmolding shape [which comprises: a sealing surface region at a base of the mandrel; and a tube contacting region adjacent the sealing surface region];  
injection molding the [a] second polymer over the tube and the mandrel in the void of the mold; and  
crosslinking the first and second polymers.

Please cancel Claims 2-62 without bias or prejudice.

Please insert the following new claims:

63. (new) The process of claim 1 wherein the overmolding shape comprises a sealing surface region at the base of the mandrel and a tube contacting region adjacent thereto.
64. (new) The process of claim 1 wherein the overmolding shape comprises an internally threaded engaging surface region at the base of the mandrel and a tube contacting region adjacent thereto.

65. (new) The process of claim 1 wherein the overmolding shape comprises an externally threaded engaging surface region at the base of the mandrel and a tube contacting region adjacent thereto.

66. (new) The process of claim 1 wherein the first and second polymers are polyethylene and each is independently crosslinked to an initial degree and wherein the step of crosslinking independently increases the degree of crosslinking of each polymer to a higher final amount.

67. (new) The process of claim 66 wherein the initial degree of crosslinking of each of the first and second polymers is in the range of from about 35% to about 50% and the final degree of crosslinking of each of the first and second polymers is greater than or equal to about 50%.

68. (new) The process of claim 63 wherein the sealing surface region is selected from the group consisting of a cup-shaped void and a radiused void; and wherein the tube contacting region is an essentially tubular void.

69. (new) The process of claim 68 wherein the tube further comprises an annular shelf interposed between the sealing surface region and the tube contacting region.

70. (new) The process of claim 64 wherein the internally threaded engaging surface region is an internally threaded annular void; and wherein the tube contacting region is an essentially tubular void.

71. (new) The process of claim 70 wherein the tube further comprises an n-sided shelf interposed between the internally threaded engaging surface region and the tube contacting region and wherein n is an integer value greater than or equal to 4.

72. (new) The process of claim 65 wherein the externally threaded engaging surface region is a threaded annular void; and wherein the tube contacting region is an essentially tubular void.

73. (new) The process of claim 72 wherein the tube further comprises an n-sided shelf interposed between the externally threaded engaging surface region and the tube contacting region and wherein n is an integer value greater than or equal to 4.
74. (new) The process of claim 1 wherein the tube further comprises a mesh overbraid applied prior to the injection molding step.
75. (new) The process of claim 63 which further comprises the step of inserting a nut onto the tube after the step of injection molding.
76. (new) The process of claim 63 which further comprises the step of molding a retaining ring onto the first polymer tube by heating a portion of the tube posterior to the nut and compressing at least one end of the tube along a longitudinal axis of the tube, a mandrel having been inserted into the tube prior to the step of compressing.


#### REMARKS

This case is a divisional of a parent application filed as Ser. No. 08/827,305 on 28 March 1997.

The parent case contained Claims 1-62 as originally filed. Of those claims initially filed, an election was made to prosecute the product claims (Claims 31-46 and 56-62) in the parent application. This application is intended to prosecute the process claims which were non-elected in the parent application. Of the claims, Claim 1 from the parent case is retained and is amended to give a generic claim to prior claims 1, 22 and 47 in the parent case. New Claims 63-65 provide the species embodiments of Claims 1, 22 and 47, respectively, in dependent form. New Claim 66 provides the limitation formerly found in Claim 2 of the parent case. New Claim 67 provides limitations very similar to those of Claims 3-5 in the parent case. New Claims 68 and 69 correspond to Claims 7 and 8. New Claims 70 and 71 correspond to Claims 28 and 29. New Claims 72 and 73 correspond to Claims 53 and 54. New Claim 74 provides a limitation found in Claim 9. New Claims 75 and 76 provide the same limitations found in Claims 10 and 11 of the parent case.

The process claims of the present invention are believed to be patentable over any prior art made of record in the parent case. The review of the prior claims in amending Claim 1 and in presenting new Claims 63-76 is believed to have removed any typographical errors or problems of indefiniteness which may have been present in the parent application. The presentation of a generic claim 1 with species limitations in Claims 63-65 greatly reduces the number of claims required to be examined. For these and other reasons, the claims as presented are believed to be immediately allowable over the prior art and prompt action thereon is earnestly requested.

Respectfully submitted,

  
Stephen L. Grant  
Reg. No. 33,390

OLDHAM & OLDHAM CO. LPA  
1225 W. Market St.  
Akron, OH 44313  
330/864-5550

Atty Docket 5871-Z-DIV

# Crosslinked Overmolded Plumbing Tubes

## *Technical Field*

The invention described herein pertains generally to a crosslinked plumbing tube which has at least one overmolded end (e.g., nose cone, threaded fastener or nut) attached thereto. In one aspect of this invention, the tube is more rigid than the overmolded component while in another aspect of the invention, the tube is more flexible than the overmolded component, although there are instances wherein the rigidity of both the tube and the overmolded component are essentially the same. The overmolded tube provides an all-plastic waterway for a contained liquid or gas to flow through.

## *Background of the Invention*

In plumbing installations, copper tubing is widely employed. In risers, used for connecting tubing to fixtures or tanks, the end of the copper tubing is shaped to form a bulb sealing surface and such bulb includes a shoulder permitting the tubing and the bulb sealing surface to be drawn into biting or sealing engagement with the fixture. The cost of such copper tubing and the cost of forming the same to permit the connection to such fixtures or tanks is substantial.

In the past, polymers such as polybutylene were used in plumbing. Tubing or pipe made of polybutylene is normally joined by heat-fusion techniques, by mechanical compression, overmolding and by cold flaring. In order to provide such polybutylene tubing with a bulb sealing surface or an end cap for such purposes, a variety of techniques were employed. Two commonly employed techniques were: (1) spin-welding a separately molded bulb onto the outer diameter (O.D.) of the end of a tube; or (2) insert molding a bulb onto the O.D. of the end of a tube. All such processes have cost and performance drawbacks. In the spin welding technique, excessive clamping pressures may cause the loaded part to become dislodged or separated from the O.D. of the tubing and the interface of the parts provides a possibility of leakage. In the case of a neoprene or like washer employed on the O.D. of the tubing, depending on the configuration of the tube/washer interface, the same leakage susceptibility is potentially present. Moreover, a flange formed to receive the washer may itself create a point of weakness if excessive clamping pressures are employed. Further neoprene washers are known to deteriorate with age and temperature exposure. Lastly, insert molding forces hot material over a cold tube surface, creating a bond that is hard to predict and control.



One solution to this problem of providing polybutylene tubing with an attached bulb sealing surface of unitary construction is detailed in U.S. Patents 4,316,870, 4,446,084 and 4,525,136, which are hereby incorporated fully by reference. The thrust of these references however, is to teach the ability to maintain a constant diameter opening within the tubing. This is of necessity, due to the configuration of the mold cavity, and insertion of the mandrel inside the tubing during some of the processing steps.

After solving the sealing surface issues, the ability to bell an opposed end of the tubing, without any accompanying wall thickness compromise, which would make the product unsuitable for all plumbing applications, was addressed. Prior art solutions to the formation of a bell on one end of polybutylene tubing is by heating a portion of the end of the tubing, followed by insertion of a mandrel into the heated open end, the O.D. of the mandrel being matched to the targeted inner diameter (I.D.) of the tubing. While this approach will bell the tubing, it is incapable of reproducibly making tubing product with a constant wall thickness of  $0.062'' + 0.010''$  throughout the belled end, particularly in the neck region of the bell. This is due to the fact that the bell is made by expanding the I.D. and thus thinning the walls. A solution to this problem is found in U.S. patent 5,527,503, the teachings of which are hereby fully incorporated by reference.

The trend today however, is to shift from thermoplastic materials, e.g., polypropylene, polybutylene, etc., to combined thermoplastic/thermoset materials, e.g., crosslinked polyethylene wherein at least a portion of the polymer is crosslinked, for example approximately 65% thermoset / 35% thermoplastic. However, this shift in materials is not simple in that there are several processing changes which must be incorporated in order to fabricate acceptable parts. Since thermosets in general, cannot be extruded like thermoplastics, differing processing conditions must be employed in different sequences in order to achieve similar functionality for the thermoset/thermoplastic product. While thermoplastic material can chemically bond to itself, as the percentage of crosslinking increases, there is less thermoplastic remaining to form this chemical bond. Therefore, one of the keys to this invention is the recognition of the need to form overmolded ends at the earliest time when they are the least crosslinked. When crosslinking using radiation, this is before any crosslinking occurs. With silane crosslinking, this is typically after extrusion, but before crosslinking is complete. In a preferred embodiment, the tube and the overmolded plastic will both be essentially



about 35% crosslinked, and subsequently permitted to complete the crosslinking process after overmolding.

However, in many plumbing applications, a need exists for a connector wherein the characteristics of the nose cone are different from those of the tube, yet still retain the leak-proof aspects of a one-piece connector. It is desirable to produce a riser tube which is rigid enough to withstand pressures in plumbing, but which has a nose cone which is less flexible than the tube which permits sealing engagement in a leak-proof manner with a fitting. Alternatively, it is also desirable to produce a riser tube which is flexible enough to permit installation in a tight geometric configuration, yet still have a nose cone which is sufficiently rigid to permit sealing engagement in leak-proof manner with a fitting. Typically, tubing rigidity and nose cone flexibility have always been properties which were antagonistic to each other. By using the technology described in this application, it is possible to custom tailor the needs of the tubing and nose cone, which depending on the end application, may require that the rigidity of the tubing and nose cone may be essentially the same.

### *Summary of the Invention*

In accordance with the present invention, there is provided a method by which a nose cone of a first rigidity is overmolded onto a plastic tube of a second rigidity, and wherein the relationship between the first rigidity and second rigidity may be the same or different. When the rigidity is different, the relationship between the first and second rigidity can be either that the first rigidity is more flexible than the second rigidity or vice versa. One of the keys to controlling the rigidity of the respective components is the density of each part. Typically, and especially with polyethylene, the higher the density of the polymer, the more rigid the component. By controlling the density and/or possibly the degree of crosslinking of the polymer, it is possible to custom tailor the needs of the tube and the nose cone.

In another embodiment of this invention, the rigidity of the tube and the overmolded component are essentially the same, with the overmolding occurring when the tube and overmolded component, e.g., nose cone, are either non-crosslinked or crosslinked to a limited degree, followed by a continuation of the crosslinking process to a second higher degree of crosslinking. This provides the best seal between the molded and extruded surfaces.

These and other objects of this invention will be evident when viewed in light of the drawings, detailed description, and appended claims.

### ***Brief Description of the Drawings***

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in the specification and illustrated in the accompanying drawings which form a part hereof, and wherein:

Fig. 1 is a cross-section view of a plastic tube showing one connector overmolded thereto;

Fig. 2 is a side view of the plastic tube of Fig. 1 including a nut shown in cross-section positioned on the tube and retained in proximity to the sealing surface via protuberances on the connector;

Fig. 3 is a top view of one half of a mold used in the process of overmolding a nose cone onto a plastic tube;

Fig. 4 is a view similar to Fig. 3 showing the plastic tube inserted over the mandrel in the mold;

Fig. 5 is a view similar to Fig. 4 with the nose cone shown overmolded onto the plastic tube;

Fig. 6 is a side view shown in partial cross-section of an overmolded nut;

Fig. 7 is a view similar to Fig. 1 showing the nose cone in cross-section and the tube having an overbraid; and

Fig. 8 is a side view shown in partial cross-section of an overmolded threaded connector.

### ***Detailed Description of the Invention***

Referring now to the drawings wherein the showings are for purposes of illustrating the preferred embodiment of the invention only and not for purposes of limiting the same, the Figures show cut lengths of plastic tubing which have overmolded components as well as the process used to achieve such a product.

As seen in Fig. 1, a plumbing connector 10 is shown having a plastic nose cone 2 at one end which is secured to plastic tube 18 having two opposed ends 20,22 in a leak-proof manner. Tubing segment 4, the portion of tube 18 which is not attached to nose cone 2, can be of any desired length and this dimension plays no part in the invention. The nose cone 2 will have a front face 16, and a conical or radiused sealing surface 14 which terminates at shelf 12. The inner surfaces of cylindrical rear surface 8 and radiused surface 6 are used to affix the nose cone in a leak-proof manner to the corresponding section of the outer surface of tubing segment 18. Nose cone 2 has an inner diameter

$D_2$  which essentially matches the outer diameter of tube 18. The inner diameter  $D_1$  of tube 18 will be smaller than that of  $D_2$  by a thickness  $t$  of the tube.

The connector 10 will have its tubing segment 18 of a first rigidity and a first flexibility and a nose cone 2 of a second rigidity and a second flexibility. In one embodiment of the invention, the first rigidity will be harder than the second rigidity and the first flexibility will be less than the second flexibility, i.e., the nose cone will be "softer" and more "flexible" than the tube. In a second embodiment of this invention, the relationship will be the inverse of that described for the first embodiment, the first rigidity will be softer than the second rigidity and the first flexibility will be greater than the second flexibility, i.e., the nose cone will be "harder" and less "flexible" than the tube. This second embodiment configuration is preferred when higher pressures may be encountered in the application and when maximum flexibility of the connector is required. In yet a third embodiment of this invention, the rigidity of the nose cone and the tube will be essentially the same. In discussing the above terminology, it should be recognized that while there are no definite boundaries of the term definitions, which is important is the relative physical parameters with respect of one component to the other. In general, "soft" durometers are as low as 60 durometer Shore A and "rigid" durometers could be as high as 90 durometer Shore A. Phrased in a slightly different manner, rigid would be most similar to hard thermoset plastics whereas flexible would be most similar to rubbery thermoplastics.

The leak-proof engagement of nose cone 2 with tube 18 is effected by a process known to those skilled in the art as overmolding. In the first embodiment of this invention, the application which uses a rigid tube and a flexible nose cone, a low density polyethylene nose cone is molded over a high density polyethylene tube prior to the step of crosslinking. In this manner, it is possible to obtain a material to material bond, thereby effecting the leak-proof attachment of the nose cone to the tube. The resulting connector is crosslinked by means known in the art, e.g., silane crosslinking, radiation crosslinking, etc. In a variation of this process, it is possible to begin with material which is partially crosslinked before the overmolding process, followed by further crosslinking subsequent to the leak-proof attachment. The benefit of this embodiment is that the soft nose cone is a forgiving sealing surface. The application however, is generally limited to lower pressure applications in that due to the softness of the nose cone, it is possible under sufficient pressure, to have the shelf 12 and sealing surface 14 deform sufficiently to slip through nut 26, thereby prematurely disconnecting the

tube from the orifice. As shown in Fig. 2, a nut 26 having a plurality of threads 28 is shown which is used to effect sealing engagement with a mating orifice. In a most preferred embodiment of the invention, the connector will have at least one ridge 32 molded into the connector to retain an appropriately sized nut.

5 In a more preferred embodiment of this invention, the connector will be a flexible tube and a harder, more rigid nose cone. In this embodiment, a high density glass-filled polyethylene nose cone or other molded configuration, (e.g., threaded connector or nut) is molded over a low density polyethylene tube prior to the step of crosslinking or after a limited degree of crosslinking has occurred. In this manner, it is possible to obtain a material-to-material bond, thereby effecting the  
10 leak-proof attachment of the nose cone to the tube. The resulting connector is crosslinked by means known in the art. In a variation of this process, it is possible to begin with material which is partially crosslinked before the overmolding process, followed by further crosslinking subsequent to the leak-proof attachment. The benefit of this embodiment is that the hard nose cone is suitable for higher pressure applications than possible in the first embodiment. Due to the more rigid nature of the nose  
15 cone, it is not possible for shelf 12 and sealing surface 14 to deform sufficiently to slip through nut 26, thereby prematurely disconnecting the tube from the orifice. In addition, due to the flexible nature of the tube, it is possible to twist the tube to conform to an irregular pathway, without having the tube inner diameter  $D_1$  decreased due to kinking of the tube.

The preferred polymer in this invention is polyethylene. The main features which influence  
20 the properties of polyethylene are (1) the degree of branching in the polymer; (2) the average molecular weight; and (3) the molecular weight distribution. Polyethylene is partially amorphous and partially crystalline. The percent crystallinity has a marked effect on physical properties. Side chain branching is the key factor controlling the degree of crystallinity. High density polyethylene (HDPE)  
25 has fewer side-chain branches than low density polyethylene (LDPE), therefore, a more tightly packed structure and a higher degree of crystallinity can be obtained. HDPE is characterized as being a highly crystalline material, perhaps as much as 85% while LDPE exhibits crystallinities as low as 50%. The amount of branching is controlled in the LDPE and HDPE processes in order to adjust crystallinity and physical properties.

The density of polyethylene affects many physical properties. In general, increasing density increases stiffness, tensile strength, hardness, heat and chemical resistance, opacity and barrier properties, but reduces impact strength and stress-crack resistance.

As used in this application, low density polyethylene will mean an ethylene polymer which has a specific gravity of about 0.89 to 0.915, a tensile strength of about 1,500 psi; an impact strength over 10 ft-lb/in./notch; a thermal expansion of  $17 \times 10^{-5}$  in/in/°C. When discussing high density polyethylene, an ethylene polymer which has a specific gravity of about 0.94 to 0.95, a tensile strength of about 4,000 psi; impact strength of 8 ft-lb/in./notch. It is of course recognized, that it is possible to use materials which are a blend of various polyethylenes or other compatible materials in many different ratios. When discussing crosslinked polyethylene, an ethylene polymer, either low or high density, will be intended wherein the polymer has been either exposed to radiation with electron beam or gamma rays, crosslinking taking place through a primary valence bond, or by chemical crosslinking means, such as by using an organic peroxide, or by using silane. The range of crosslinking can be as low as from 30% to 90% or higher.

Crosslinking can of course, be accomplished in many different ways. Crosslinking can be performed during the extrusion process, e.g., by the Engel process, or post-extrusion, e.g., by a silane process or a peroxide process or combinations thereof wherein some crosslinking occurs during the extrusion step and is completed in a hot bath post-extrusion step. Each process has a crosslinking catalyst that causes the polymer to crosslink when certain temperature and pressure and/or humidity are used. One additional way to crosslink is to use radiation. In this method, extruded tubes are passed under a radiation unit and the exposure causes crosslinking. It usually is more economical to radiate straight tubes since the economics revolve around how many parts will fit on a cart that rolls under the beam. However, this does not represent the only embodiment contemplated within the invention. It is envisioned that under some circumstances, it would be appropriate to crosslink the final product.

Fig. 3 shows one half of a mold 40 which would be effective in the overmolding process. The mold comprises a mandrel 44 having extending portions 46, 48 and terminating at a point outside the mold 40. It is not necessary that the mandrel extending portion have two different diameters as shown in Fig. 3, although this is preferred. At least a portion of the extending mandrel will have an outer diameter which essentially matches the inner diameter of the plastic tube, to permit



the insertion of the tube onto the extending portion of the mandrel. The mold will have a radiused or conical base 50 which will form the sealing surface of the nose cone terminating in a mold shelf recess 52. Cylindrical mold portion 54 extends from this shelf recess and terminates in radiused mold portion 56. Overmolding feed conduit 58 is used to transfer flowable polymer from a source (not shown) into mold 40 via transfer conduit 60 shown in the Figure to be at the location of mold shelf recess 52, although there is no reason to limit the location to this point, other entry points being satisfactory depending upon design criterion and location of the parison. Connectors 42 are used for heating and optionally cooling of the mold.

Fig. 4 shows the positioning of the plastic tube 18 onto the extending portion 48 of the mandrel 44 terminating at the terminal shelf 47 of the first larger extending portion 46 of the mandrel 44 while Fig. 5 shows the product after the overmolding process has been completed. It should be recognized that the precise location of the first terminal shelf 47 of the first extending portion 46 of the mandrel 44 need not coincide with the location of nose cone shelf 12, although it often will be in the vicinity thereof. In some instances, the extending mandrel portion will only be the second smaller diametered section, and the first extending portion will be eliminated completely.

In operation, the mold cycle times and temperatures used will be dependent upon the composition of the materials used and the geometry of the part(s) being molded as well as the degree of dimensional control required for the molded product. It is possible to have a cycle time range from five seconds to several minutes depending on the curing time for the molded material. In general for crosslinked polyethylene tubing, the temperatures used will range from 350°F melt up to 540°F although similar operations variables which were discussed for the mold cycle time are equally applicable here. Molding pressure will also be subject to similar considerations, and for crosslinked polyethylene, can range from 200 psi to 2,000 psi (hydraulic). In general, the colder the melt, the higher the pressure which is required to fill and pack the mold. If the part which is to be molded has a very thick section, then it may be desirable to use a low melt temperature, high melt pressure and as low a cycle time as possible. Given the interactivity between the above variables in an injection molding process, the range of the processing variables is almost limitless within broad guidelines and within the skill of those in the art.

While the above discussion has focused attention on the overmolding of a nose cone, there is no need to limit the invention to such. In fact, as shown in Fig. 6, an overmolded nut is shown, said

nut having been formed by analogous processing to that described previously for nose cones. The overmolded nut 61 is shown affixed to tube 18, the nut containing a threaded bore 64 and a shoulder 62. The inner surfaces of the barrel portion 68 and radiused taper 66 are used to affix the nut in a leak-proof manner to the corresponding section of the outer surface of tubing element 18. This nut in a preferred embodiment will be glass-filled polyethylene and will optionally incorporate an "O" ring to seal. In this configuration, it is obviously recognized that the tube would turn while screwing the riser into place.

Yet another variation, an overmolded threaded connector, is shown in Fig. 8, which is similar to that shown and described previously with reference to Fig. 6, where an overmolded nut was shown. The threaded connector is formed by analogous processing to that described previously for nose cones, the mold design being different. The overmolded threaded connector 63 is shown affixed to tube 18, the connector being threaded 65 and having a shoulder 62. The inner surfaces of the barrel portion 68 and radiused taper 66 are used to affix the nut in a leak-proof manner to the corresponding section of the outer surface of tubing element 18. This threaded connector in a preferred embodiment will be glass-filled polyethylene.

In Fig. 7, yet another embodiment of this invention is shown wherein an overbraid 70 has been applied to the tube prior to the overmolding process. The overbraiding could be fiberglass, nylon webbing, stainless steel, etc.

### **Discussion**

What has been described above, is a process for overmolding tubes which comprises the steps of inserting a tube of a first polymer having an inner diameter at least partially into a mold and at least partially onto a cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said mandrel dimensioned to allow the inner diameter of the tube to slide thereon and forming in one embodiment, a sealing surface thereupon. The mold, which is a split mold, will contain by necessity, a void which comprises a sealing surface region at a base of the mandrel and a tube contacting region adjacent the sealing surface region. A second polymer is injection molded over the first polymer tube and the mandrel in the void of the mold and the polymers are crosslinked by using any of the crosslinking methodologies well known in the art.

In a preferred embodiment, the first and second polymers are polyethylene and independently crosslinked to an initial degree and wherein the step of crosslinking independently increases the

degree of crosslinking to a second higher final amount. The density of the polymers will impact the degree of flexibility of the product, and by using the process described, it is possible to tailor the characteristics of the final product. In one aspect of the invention, the initial degree of crosslinking of the first and second polymers is independently less than 50% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%. In another aspect of the invention, the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 40% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%. In yet another aspect of this invention, the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 35% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%. When it is desired that the tube be flexible and the nose cone be more rigid, then the density of the first polymer will be less than the density of the second polymer.

As seen in the Figures, the sealing surface region is selected from the group consisting of a cup-shaped void and a radiused void and the tube contacting region is an essentially tubular void. In a more preferred embodiment, an annular shelf is interposed between the sealing surface region and the tube contacting region. In one aspect of the invention, the tube polymer will be overbraided with a mesh, the mesh being either a woven or open mesh.

At times, it may be desirable to insert a nut onto the first polymer after the step of injection molding. Optionally, it is possible to mold a retaining ring onto the first polymer tube by heating a region posterior of the nut until it becomes soft, and at least one end of the tube is compressed along a longitudinal axis of the tube, such as described in U.S. Patent No. 4,803,033, the teachings of which are hereinby fully incorporated by reference. As taught in the patent, the tube is preheated at a precise area and grippping dies are used to compress the heated area. Upon compression, the heated area is forced to bulge out and fold to form the flange or bellows. A mandrel is inserted into the tube prior to the compression to insure that the tube bulges outwardly.

In another embodiment of this invention, it is possible to overmold a nut or a threaded connector over one end of the tube, rather than the sealing surface discussed previously. The process involves the same steps with the essential difference being in the mold design, which would contain a void which comprises an internally threaded engaging surface region at a base of the



mandrel. In a preferred embodiment, an n-sided shelf is interposed between the internally threaded engaging surface region and the tube contacting region and n is an integer value greater than or equal to 4.

The best mode for carrying out the invention has been described for the purposes of illustrating the best mode known to the applicant at the time. The examples are illustrative only and not meant to limit the invention, as measured by the scope and spirit of the claims. The invention has been described with reference to preferred and alternate embodiments. Obviously, modifications and alterations will occur to others upon the reading and understanding of the specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

*What is Claimed is:*

1. A process for overmolding tubes comprising the steps of:
  - inserting a tube of a first polymer having an inner diameter at least partially into a mold and at least partially onto a cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said mandrel dimensioned to allow the inner diameter of the tube to slide thereon, said mold containing a void which comprises:
    - a sealing surface region at a base of the mandrel; and
    - a tube contacting region adjacent the sealing surface region;
  - injection molding a second polymer over the tube and the mandrel in the void of the mold;
  - and
  - crosslinking the first and second polymers.
2. The process of claim 1 wherein the first and second polymers are polyethylene and independently crosslinked to an initial degree and wherein the step of crosslinking independently increases the degree of crosslinking to a second higher final amount.
3. The process of claim 2 wherein the initial degree of crosslinking of the first and second polymers is independently less than 50% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
4. The process of claim 3 wherein the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 40% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
5. The process of claim 4 wherein the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 35% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
6. The process of claim 3 wherein the initial degree of crosslinking of the first polymer is less than an initial degree of crosslinking of the second polymer.
7. The process of claim 1 wherein
  - the sealing surface region is selected from the group consisting of a cup-shaped void and a radiused void; and wherein
  - the tube contacting region is an essentially tubular void.

8. The process of claim 7 wherein the void further comprises  
an annular shelf interposed between the sealing surface region and the tube contacting region.
9. The process of claim 1 wherein the first polymer further comprises  
a mesh overbraid.
10. The process of claim 1 which further comprises the step of  
inserting a nut onto the first polymer after the step of injection molding.
11. The process of claim 1 which further comprises the step of  
molding a retaining ring onto the first polymer tube by heating a portion of the tube posterior  
to the nut and compressing at least one end of the tube along a longitudinal axis of the  
tube, a mandrel having been inserted into the tube prior to the step of compressing.
12. A process for overmolding polyethylene tubes comprising the steps of:  
inserting a tube of a first polyethylene polymer and crosslinked to an initial degree, the tube  
having an inner diameter at least partially into a mold and at least partially onto a  
cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said  
mandrel dimensioned to allow the inner diameter of the tube to slide thereon, said mold  
containing a void which comprises:  
a sealing surface region at a base of the mandrel; and  
a tube contacting region adjacent the sealing surface region;  
injection molding a second polyethylene polymer and crosslinked to an initial degree, said  
initial degrees of crosslinking being selected independently for the first and second  
polyethylene polymers, over the tube and the mandrel in the void of the mold; and  
crosslinking the first and second polymers to a final degree, said final degree of crosslinking  
for the first and second polymers being selected independently for the first and second  
polymers.
13. The process of claim 12 wherein the initial degree of crosslinking of the first and second  
polymers is independently less than 50% and the second final degree of crosslinking for the  
first and second polymers is independently greater than or equal to about 50%.
14. The process of claim 3 wherein the initial degree of crosslinking of the first and second polymers  
is independently about less than or equal to about 40% and the second final degree of

crosslinking for the first and second polymers is independently greater than or equal to about 50%.

15. The process of claim 14 wherein the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 35% and the second final degree of crosslinking for the first and second polymers is independently greater than or equal to about 50%.

16. The process of claim 12 wherein an initial degree of crosslinking of the first polymer is less than an initial degree of crosslinking of a second polymer.

17. The process of claim 12 wherein  
the sealing surface region is selected from the group consisting of a cup-shaped void and a radiused void; and wherein  
the tube contacting region is an essentially tubular void.

18. The process of claim 17 wherein the void further comprises  
an annular shelf interposed between the sealing surface region and the tube contacting region.

19. The process of claim 12 wherein the first polymer further comprises  
a mesh overbraid.

20. The process of claim 12 which further comprises the step of  
inserting a nut onto the first polymer after the step of injection molding.

21. The process of claim 12 which further comprises the step of  
molding a retaining ring onto the first polymer tube by heating a portion of the tube posterior to the nut and compressing at least one end of the tube along a longitudinal axis of the tube, a mandrel having been inserted into the tube prior to the step of compressing.

22. A process for overmolding tubes comprising the steps of:  
inserting a tube of a first polymer having an inner diameter at least partially into a mold and at least partially onto a cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said mandrel dimensioned to allow the inner diameter of the tube to slide thereon, said mold containing a void which comprises:

an internally threaded engaging surface region at a base of the mandrel; and  
a tube contacting region adjacent the internally threaded engaging surface region;

injection molding a second polymer over the tube and the mandrel in the void of the mold;  
and  
crosslinking the first and second polymers.

23. The process of claim 22 wherein the first and second polymers are polyethylene and independently crosslinked to an initial degree and wherein the step of crosslinking independently increases the degree of crosslinking to a second higher final amount.
24. The process of claim 23 wherein the initial degree of crosslinking of the first and second polymers is independently less than 50% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
25. The process of claim 24 wherein the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 40% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
26. The process of claim 25 wherein the initial degree of crosslinking of the first and second polymers is independently less than or equal to about 35% and the final degree of crosslinking of the first and second polymers is independently greater than or equal to about 50%.
27. The process of claim 23 wherein the initial degree of crosslinking of the first polymer is less than an initial degree of crosslinking of the second polymer.
28. The process of claim 23 wherein  
the internally threaded engaging surface region is an internally threaded annular void; and  
wherein  
the tube contacting region is an essentially tubular void.
29. The process of claim 28 wherein the void further comprises  
an n-sided shelf interposed between the internally threaded engaging surface region and the tube contacting region and wherein  
n is an integer value greater than or equal to 4.
30. The process of claim 23 wherein the first polymer further comprises  
a mesh overbraid.

31. An overmolded tube which comprises:

a tube of a first polymer having an inner diameter, an outer diameter and a proximal and a distal end, said first polymer being crosslinked to a first degree;  
an overmolded sealing surface region at a proximal end of the tube, said sealing surface region having a hole centrally disposed therethrough and comprised of a second polymer, said second polymer being crosslinked to a second degree, the first and second degrees of crosslinking of the first and second polymers being selected independently; and  
a tube contacting region adjacent the sealing surface region and comprised of said second polymer, said tube contacting region being bonded to said tube.

32. The tube of claim 31 wherein the first and second polymers are polyethylene and wherein the density of the first and second polymers is different.

33. The tube of claim 32 wherein a final degree of crosslinking of the first and second polymers is greater than an initial degree of crosslinking of the first and second polymers.

34. The tube of claim 32 wherein

the sealing surface region is selected from the group consisting of cup-shaped and radiused;  
and wherein  
the tube contacting region is an essentially tubular.

35. The tube of claim 34 which further comprises

an annular shelf interposed between the sealing surface region and the tube contacting region.

36. The tube of claim 31 wherein the first polymer further comprises

a mesh overbraid.

37. The tube of claim 35 which further comprises

a nut having a hole centrally disposed therethrough, a diameter of the hole being large enough to pass over the outer diameter of the tube yet smaller than a diameter of the annular shelf.

38. The tube of claim 37 which further comprises

a molded retaining ring on the tube, an outer diameter of the retaining ring being sufficient to retain the nut on the tube.



39. The tube of claim 33 wherein the final degree of crosslinking of the first and second polymers is greater than about 60% and an initial degree of crosslinking of the first and second polymers is less than about 50%.
40. An overmolded tube which comprises:
- a tube of a first polymer having an inner diameter, an outer diameter and a proximal and a distal end, said first polymer being crosslinked to a first degree;
  - an overmolded internally threaded engaging surface region at a proximal end of the tube, said internally threaded engaging surface region being essentially hollow and comprised of a second polymer, said second polymer being crosslinked to a second degree, the first and second degrees of crosslinking of the first and second polymers being selected independently; and
  - a tube contacting region adjacent the internally threaded engaging surface region and comprised of said second polymer, said tube contacting region being bonded to said tube.
41. The tube of claim 40 wherein the first and second polymers are polyethylene and wherein the density of the first and second polymers is different.
42. The tube of claim 41 wherein a final degree of crosslinking of the first and second polymers is greater than an initial degree of crosslinking of the first and second polymers.
43. The tube of claim 41 wherein
- the internally threaded engaging surface region is a threaded annular void; and wherein
  - the tube contacting region is an essentially tubular void.
44. The tube of claim 43 wherein the void further comprises
- an n-sided shelf interposed between the threaded engaging surface region and the tube contacting region and wherein
  - n is an integer value greater than or equal to 4.
45. The tube of claim 41 wherein the first polymer further comprises
- a mesh overbraid.
46. The tube of claim 42 wherein the final degree of crosslinking of the first and second polymers is greater than about 60% and an initial degree of crosslinking of the first and second polymers is less than about 50%.

47. A process for overmolding tubes comprising the steps of:

inserting a tube of a first polymer having an inner diameter at least partially into a mold and at least partially onto a cylindrical mandrel, the mandrel having a base and a tip, an outer diameter of said mandrel dimensioned to allow the inner diameter of the tube to slide thereon, said mold containing a void which comprises:

an externally threaded engaging surface region at a base of the mandrel; and

a tube contacting region adjacent the internally threaded engaging surface region;

injection molding a second polymer over the tube and the mandrel in the void of the mold;

and

crosslinking the first and second polymers.

48. The process of claim 47 wherein the first and second polymers are polyethylene and

independently crosslinked to an initial degree and wherein the step of crosslinking

independently increases the degree of crosslinking to a second higher final amount.

49. The process of claim 48 wherein the initial degree of crosslinking of the first and second

polymers is independently less than 50% and the final degree of crosslinking of the first and

second polymers is independently greater than or equal to about 50%.

50. The process of claim 49 wherein the initial degree of crosslinking of the first and second

polymers is independently less than or equal to about 40% and the final degree of

crosslinking of the first and second polymers is independently greater than or equal to about 50%.

51. The process of claim 50 wherein the initial degree of crosslinking of the first and second

polymers is independently less than or equal to about 35% and the final degree of

crosslinking of the first and second polymers is independently greater than or equal to about 50%.

52. The process of claim 48 wherein the initial degree of crosslinking of the first polymer is less than

an initial degree of crosslinking of the second polymer.

53. The process of claim 48 wherein

the externally threaded engaging surface region is a threaded annular void; and wherein

the tube contacting region is an essentially tubular void.



54. The process of claim 53 wherein the void further comprises  
an n-sided shelf interposed between the internally threaded engaging surface region and the  
tube contacting region and wherein  
n is an integer value greater than or equal to 4.
55. The process of claim 48 wherein the first polymer further comprises  
a mesh overbraid.
56. An overmolded tube which comprises:  
a tube of a first polymer having an inner diameter, an outer diameter and a proximal and a  
distal end, said first polymer being crosslinked to a first degree;  
an overmolded externally threaded engaging surface region at a proximal end of the tube, said  
externally threaded engaging surface region comprised of a second polymer, said second  
polymer being crosslinked to a second degree, the first and second degrees of  
crosslinking of the first and second polymers being selected independently; and  
a tube contacting region adjacent the internally threaded engaging surface region and  
comprised of said second polymer, said tube contacting region being bonded to said tube.
57. The tube of claim 56 wherein the first and second polymers are polyethylene and wherein the  
density of the first and second polymers is different.
58. The tube of claim 57 wherein a final degree of crosslinking of the first and second polymers is  
greater than an initial degree of crosslinking of the first and second polymers.
59. The tube of claim 57 wherein  
the externally threaded engaging surface region is a threaded annular void; and wherein  
the tube contacting region is an essentially tubular void.
60. The tube of claim 59 wherein the void further comprises  
an n-sided shelf interposed between the threaded engaging surface region and the tube  
contacting region and wherein  
n is an integer value greater than or equal to 4.
61. The tube of claim 57 wherein the first polymer further comprises  
a mesh overbraid.

62. The tube of claim 58 wherein the final degree of crosslinking of the first and second polymers is greater than about 60% and an initial degree of crosslinking of the first and second polymers is less than about 50%.

## *Abstract*

The invention described herein pertains generally to a crosslinked plumbing tube which has at least one overmolded end (e.g., nose cone or nut) attached thereto. In one aspect of this invention, the tube is more rigid than the overmolded component while in another aspect of the invention, the tube is more flexible than the overmolded component. In either embodiment of this invention, the tube provides an all-plastic waterway for a contained liquid or gas to flow through. The degree of flexibility is controlled independently controlling the density of the tube polymer and the overmolding polymer. In one aspect of the invention, the tube and the overmolding polymer are both partially crosslinked to independent first degrees prior to the overmolding process. Subsequent to the overmolding process, the crosslinking is continued to a higher degree for both polymers.

0593831-104696

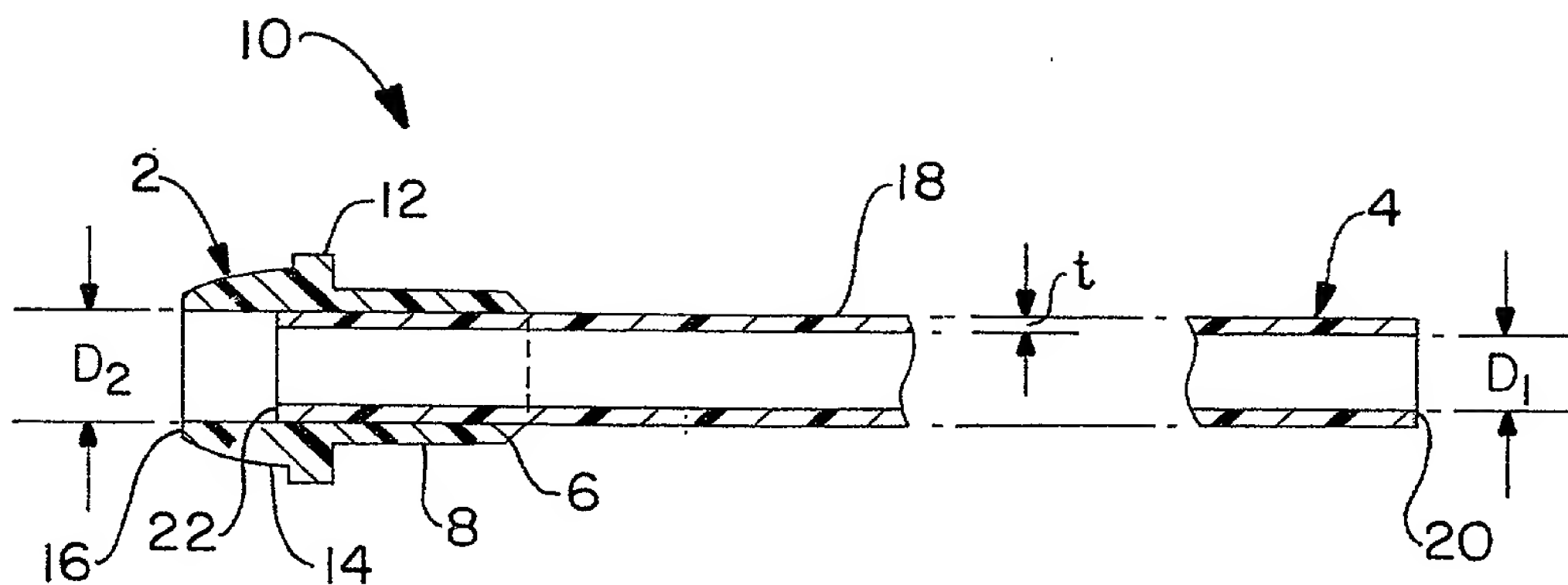


FIG. - 1

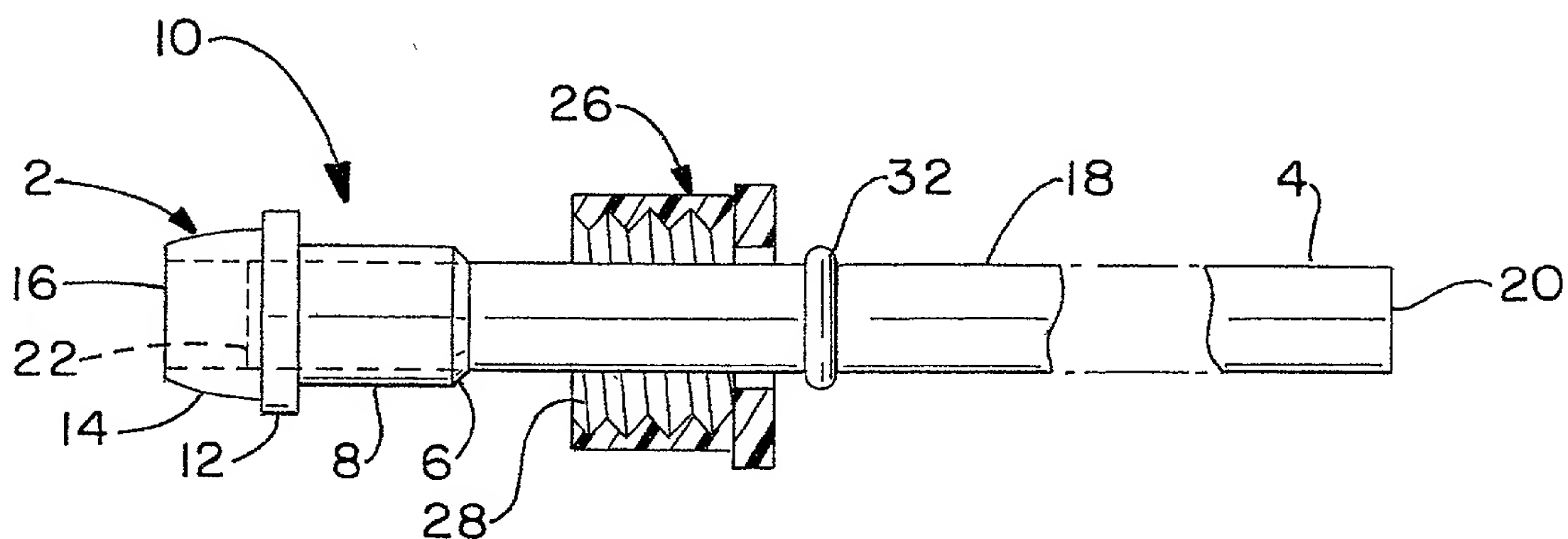


FIG. - 2

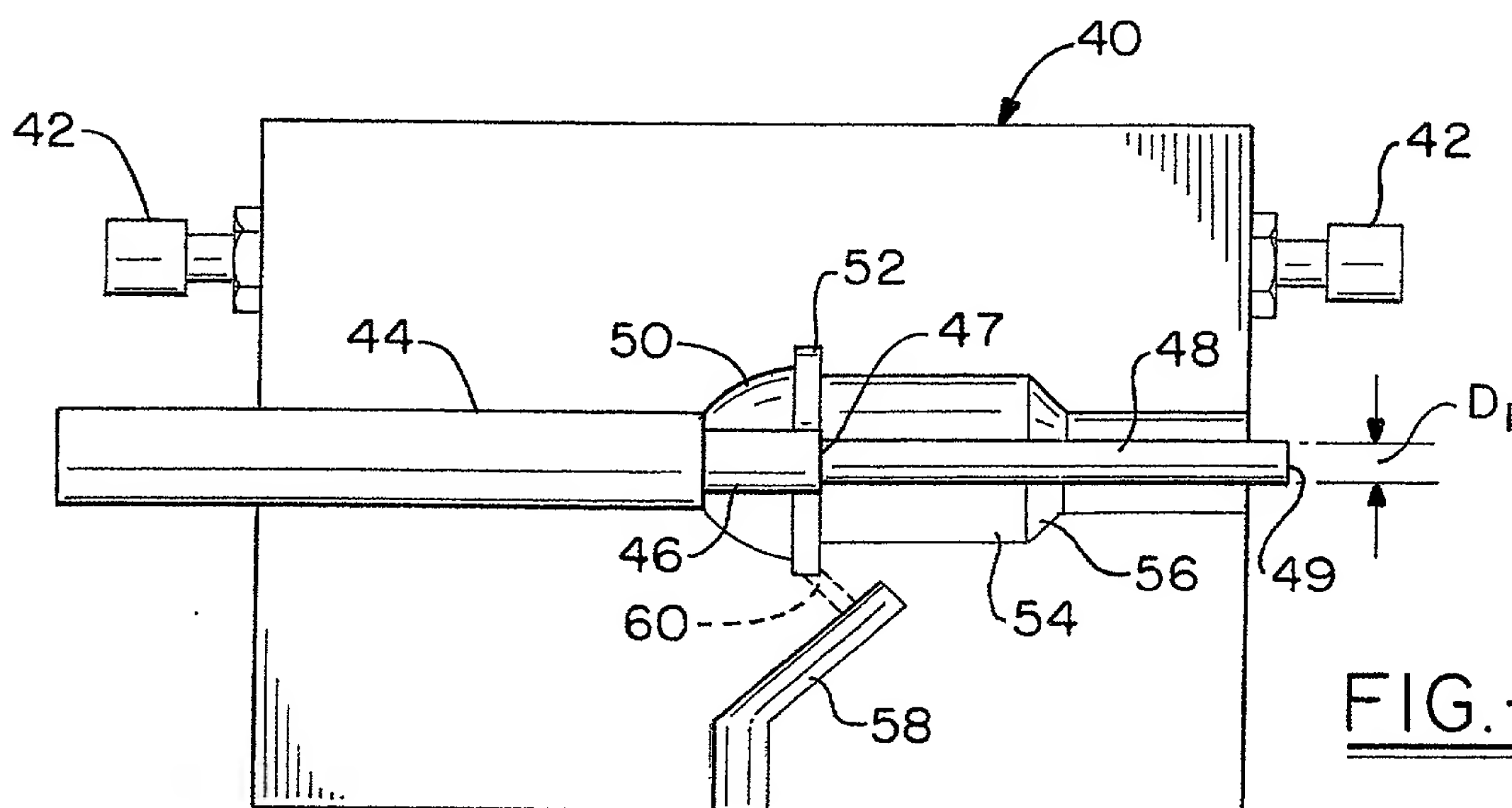


FIG. - 3

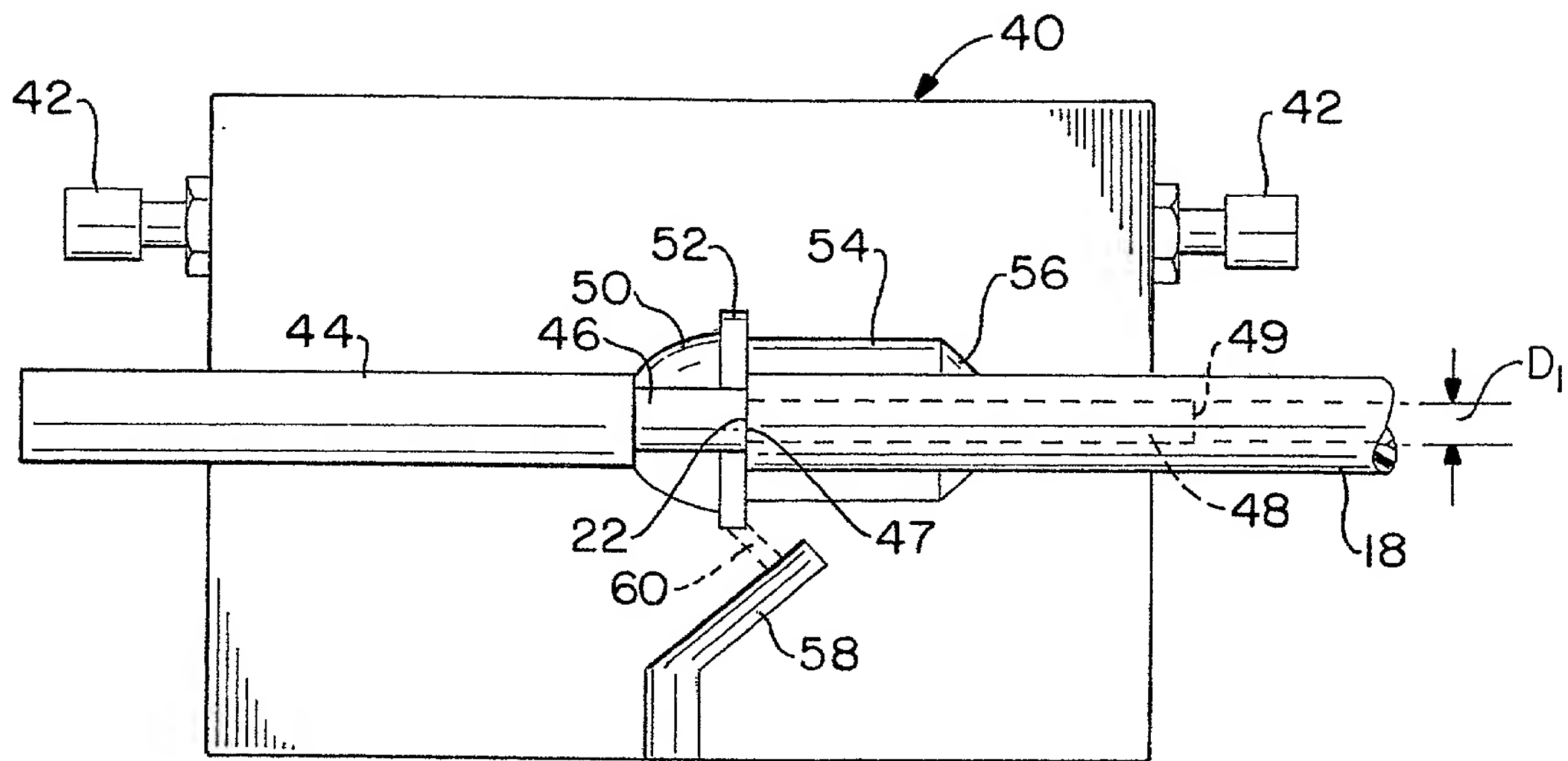


FIG. - 4

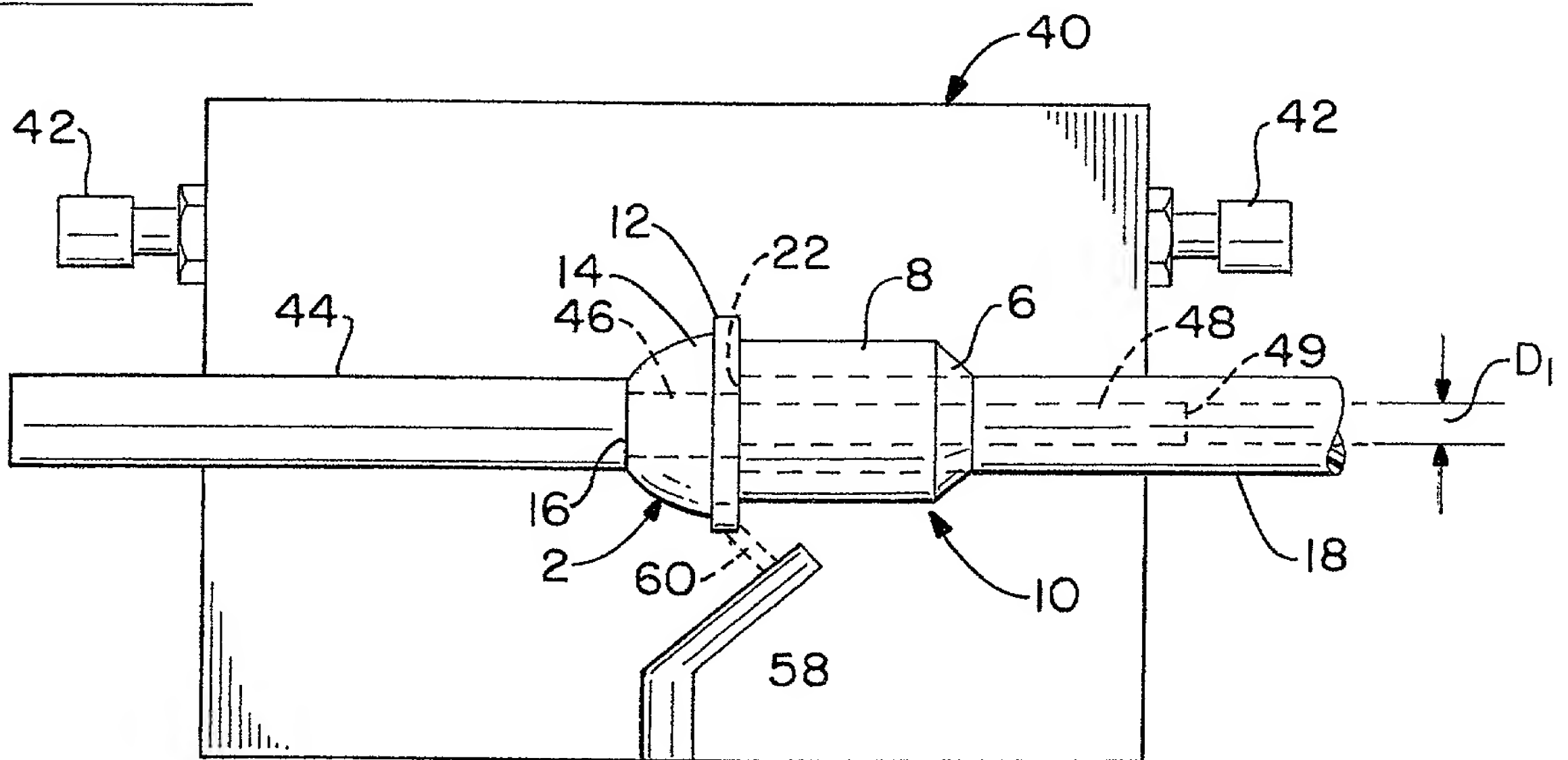


FIG. - 5

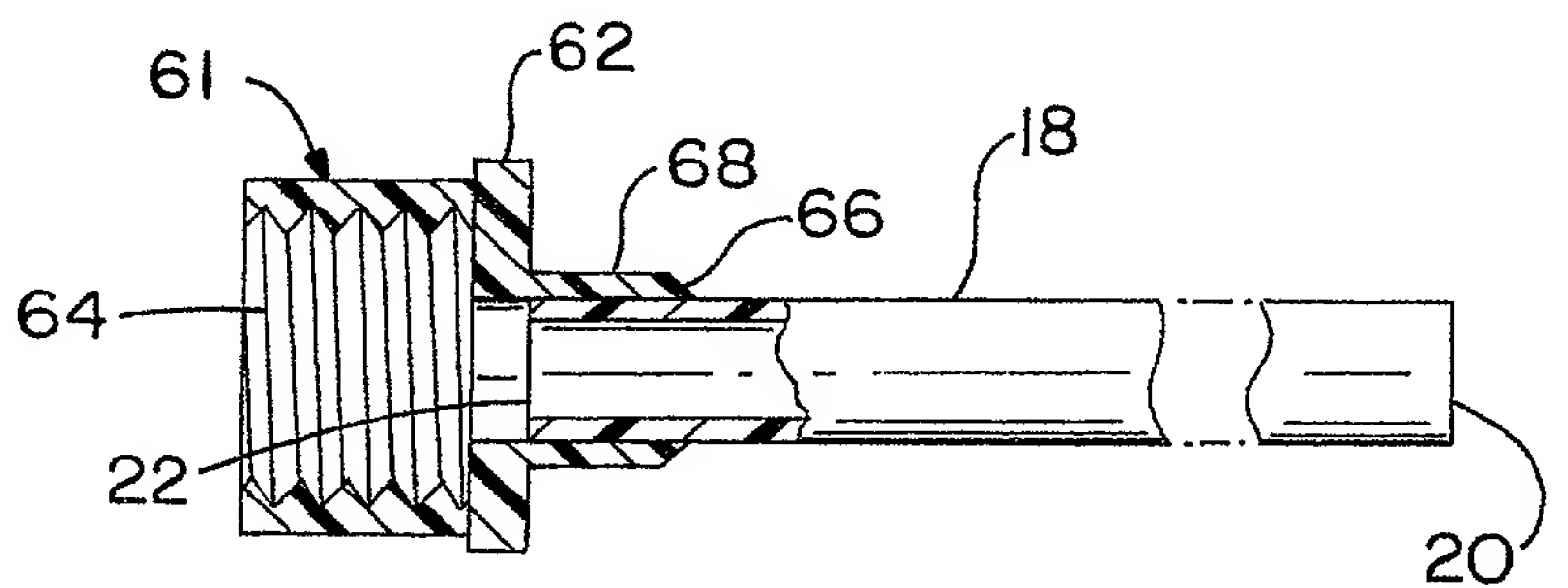


FIG. - 6

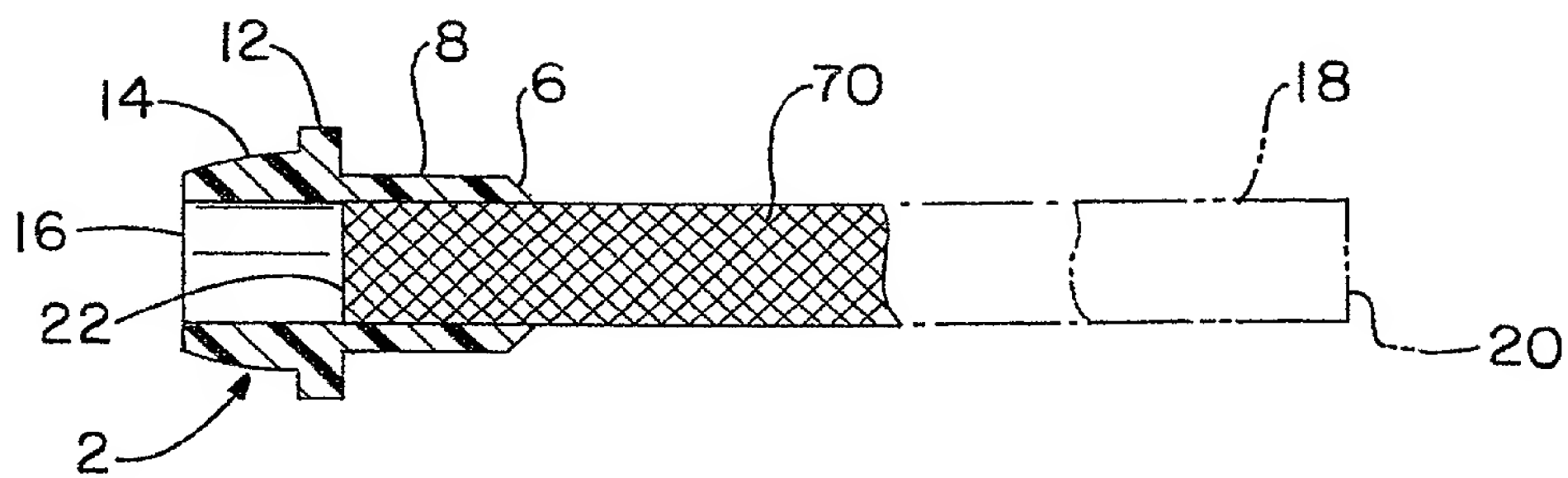


FIG. - 7

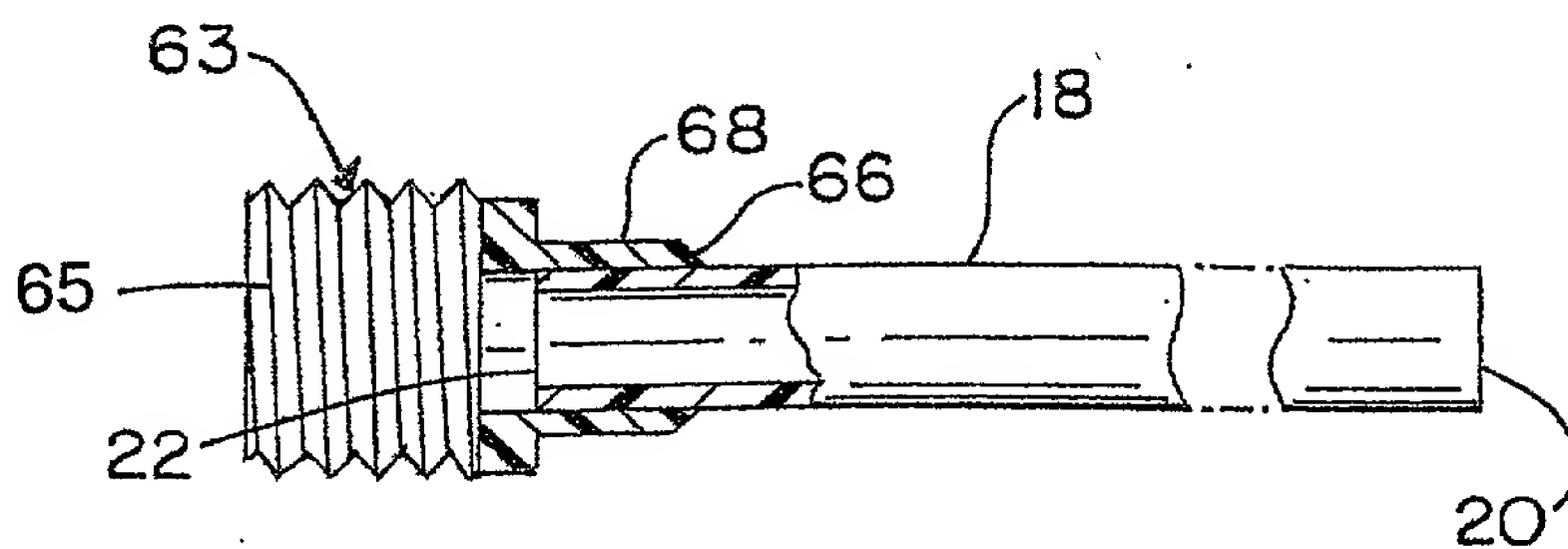


FIG. - 8

Docket No.  
5871-Z

# Declaration and Power of Attorney For Patent Application

## English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**CROSSLINKED OVERMOLDED PLUMBING TUBES**

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on \_\_\_\_\_ as United States Application No. or PCT International Application Number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Not Claimed

_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112. I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Status)  
(patented, pending, abandoned)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

\_\_\_\_\_  
(Status)  
(patented, pending, abandoned)

\_\_\_\_\_  
(Application Serial No.)

\_\_\_\_\_  
(Filing Date)

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(Status)  
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.



POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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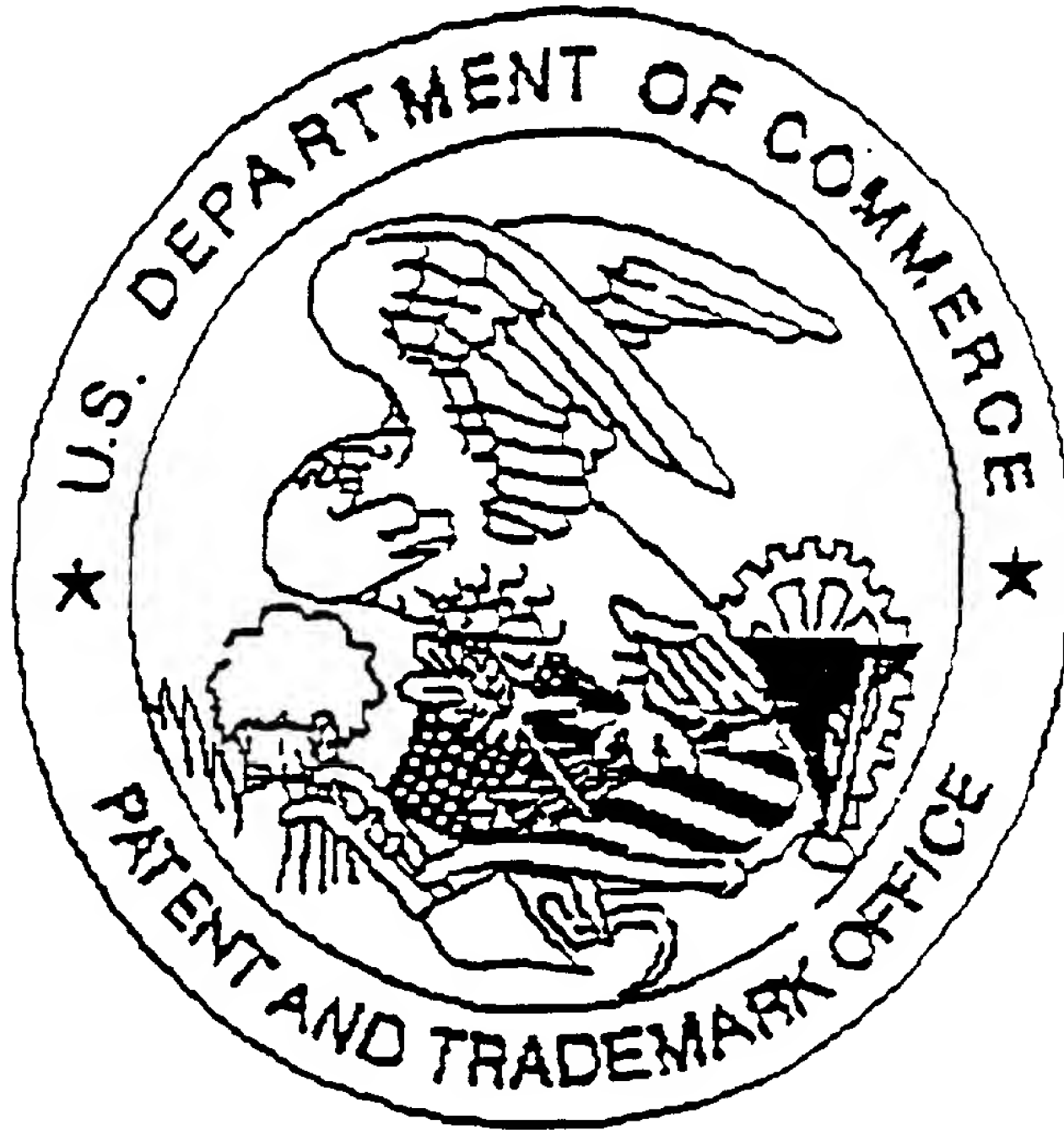
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